Syntrolysis: Simultaneously electrolyzing water and carbon-dioxide into Syngas

Two global energy priorities today are finding environmentally friendly alternatives to fossil fuels, and reducing greenhouse gases like carbon dioxide.

Idaho National Laboratory researchers have invented a technology that can do both.

INL's Syngas Generation from Co-Electrolysis uses high-temperature nuclear reactor technology and solid-oxide fuel cell technology to recycle carbon dioxide and water into Syngas, the feedstock for synthetic hydrocarbon fuel production.

This breakthrough technology also is called Syntrolysis, which is a patent-pending process that leverages nuclear-powered high-temperature electrolysis at 750-950°C in a solid-oxide electrolysis cell to convert water and carbon dioxide into synthesis gas.

"Using the well-understood Fischer-Tropsch process, Syngas can subsequently be converted into synthetic hydrocarbon fuels," said INL nuclear engineer Steve Herring. "Alternatively, Syntrolysis can produce hydrogen for use in fuel processing or for the hydrogen highway of the future."

Unlike current fuel-producing processes, Syntrolysis uses carbon dioxide from a variety of sources, including: coal-burning power plant exhaust, biomass, and agricultural waste. This carbon dioxide is converted to carbon monoxide, then combined with hydrogen extracted from water to produce Syngas. From Syngas, synthetically derived hydrocarbon fuels and products can be made.

"We have demonstrated the feasibility of the Syntrolysis process for producing hydrogen and carbon monoxide, or Syngas, here in the laboratory over thousands of hours of testing," said INL research engineer Jim O'Brien. "We believe this is an improvement over other processes for producing Syngas because it can be based on noncarbon sources of electricity and processes such as nuclear. We also have demonstrated that overall process could be carbon-neutral, if the feedstock for the CO2 is, for example, based on biomass. By combining carbon-free electricity and heat sources, Syntrolysis essentially recycles carbon material from many sources, avoids

consuming nonrenewable energy, produces no sulfur, delivers a scalable process, and creates the potential for greater energy independence in the near term."

For hydrogen production, the solid-oxide electrolysis cell has conducting electrodes on either side of the electrolyte that produce hydrogen from steam on the cathode side of the electrolyte, while oxygen ions are transported through the solid-state electrolyte to the anode side, producing oxygen gas. The exiting mixture, which may be 90% hydrogen, is passed through a separator to purify the hydrogen.

"Syntrolysis offers an affordable, domestic, long-term carbon recycling process that produces the feedstock for synthetic fuels and hydrogen," said INL research engineer Carl Stoots. "This would increase America's energy self-reliance for transportation needs and manufacturing of products, plus significantly reduce carbon emissions to the environment. It also produces valuable hydrogen for industrial and energy processes, as well as for the hydrogen highway of the future."

In summary, Syntrolysis:

- Consumes and recycles CO_2 instead of producing it,
- Produces sulfur-free Syngas for synthetic hydrocarbon fuel production,
- Avoids consumption of nonrenewable fossil fuels,
- Produces hydrogen that can be used for upgrading poor-quality oil reserves, and
- Provides a bridge to the future hydrogen economy.

Syntrolysis offers a future where transportation fuels are domestically produced, environmentally friendly and independent of depletable, polluting fossil resources.